

Status Report on NsG-209-62

Development of a Life Detector and Analytical Instruments for
Planetary Soils

(Report, September 1961 to February 1963)

N 64 22783

Code 1

Cat. 16

NASA CW 56523

I. Life Detector:

The life detecting instrument, christened by Mr. Richard Davies of JPL the "Wolf Trap", has been subjected to extensive design analysis by three companies who were interested in developing a flight model. Proposals were received from Bausch and Lomb, Rochester, New York; Matrix Research and Development Corporation, Nashua, New Hampshire; and Ball Brothers Research Corporation, Boulder, Colorado. After extensive evaluation of the proposals by myself and Dr. C.R. Weston, by personnel of JPL, and after a vender survey conducted by JPL, the proposal of Ball Brothers was accepted. Details of their proposal and the time table for the construction of the flight model of the Wolf Trap are contained in a proposal to be submitted to NASA by April first.

Based on the present plans for the Wolf Trap we plan to publish a paper giving technical details of its construction. The material to be presented in this paper will also form the substance of a report to be given by myself at a COSPAR meeting in Warsaw, Poland, June 1963.

II. Chemical Analysis of Planetary Soils:

We have devoted some effort to the construction of a device which will be able to characterize major soluble constituents of planetary soils. Dr. C.R. Weston has joined this laboratory and is working on this project. The principle of this device is outlined below and illustrated in figure 1.

Analysis is carried out by paper chromatography ; the information transmitted is the R_f of individual spots. The chromatography paper is supplied as one continuous strip, impregnated with a narrow strip of hydrophobic material to divide it into unit lengths (one unit length = distance from A to B).

The apparatus can select on command a variety of liquids with which to extract a soil sample, a variety of spray reagents to make spots visible, if needed. The banks of developers, extractors, and spray reagents can be moved at right angles to the chromatography strip to center the selected reagent over the strip.

OTS PRICE

XEROX

\$

110 ph

MICROFILM

\$

Status Report on NsG-209-62 (Cont'd)

An analysis consists of the following sequence of operations: A soil sample from a sampling device is added to an extraction funnel containing some suitable liquid (water, buffered salt solution, acid, base, organic solvent, etc.) and agitated by vibration. During this operation the container in which the apparatus is housed is closed. After extraction a magnetic valve at the bottom of the extractor is opened to admit a very slow flow of extract (from which solid particles have been removed by a filter plate) to the paper. The opening of the "sea cock" to the lunar or martian environment will allow the drops to dry as they touch the paper.

After a suitable sample has been applied to the paper the extractor valve and the sea cock are closed, a selected developer is racked into place and the developing tank is filled to the level indicated by the dotted line. The developer cannot migrate past point A towards the reserve reel because of the plastic impregnation, but will migrate in the direction of the takeup reel, thereby resolving some of the components of the mixture deposited at the origin. When the solvent front reaches the limit contacts, the increased conductivity at that point signals an opening of the valve on the developing tank and of the sea cock. The developer drains out and the chromatogram dries. The sea cock is again closed. Next the chromatography strip is slowly moved in the direction indicated for one unit length. As it moves past the bank of sprag reagents some desired agent may be applied (thioacetamide for heavy metals, ninhydrin for amino acids, etc.); and the reaction speeded, if need be, by passage over a heated wire. Alternatively, other spots may be scanned directly in the UV without application of reagents.

As the chromatogram moves past the phototube, the location of spots is transmitted and recorded. At the completion of the scan, the apparatus is ready for the next experiment. Knowing the extraction fluid, developing solvent, reagent used to make spots visible, R_f , and possible color or spot, a good deal of organic and inorganic analysis can be carried out on lunar and planetary surfaces.

The enclosed photograph shows part of the laboratory version of the automatic paper chromatograph. The glass chamber contains a movable paper strip for chromatography, and the plastic cylinder embodies the pumping device which transfers soil extract to paper. The detailed drawing shows the interior workings of this pump which can transfer measured amounts of soil extracts on command.

Status Report on NsG-209-62 (Cont'd)

III. Bacteriological Studies

Consideration of the environment in which microorganisms may live on other planets raises problems which can be studied on earth. Should Mars, for instance, be indeed anaerobic, then it may provide a suitable environment for a variety of anaerobic bacteria which are not yet known on earth, but which may exist here. For instance, it is at present not possible to envision a complete nitrogen cycle in the absence of oxygen. The only method for the oxidation of ammonia depends on oxygen, according to our present knowledge. Should there be no oxygen on Mars, then we are forced to one of two conclusions: Either there is no nitrogen cycle and all biologically important nitrogen is always present on the ammonia level, or there exists an anaerobic mechanism for ammonia oxidation. One possible pathway which suggests itself is the oxidation of ammonia by photosynthetic bacteria. Although no such organisms are known at present, it might be profitable to undertake a systematic search for photosynthetic bacteria which can utilize ammonia as the external electron donor.

We have begun a search for organisms which may occupy other oxygen-free ecological niches which according to our present knowledge are not yet occupied. We have succeeded in isolating a photosynthetic organism which appears to oxidize methane in the presence of carbon dioxide. We believe that the study of this and of other as yet unknown organisms will clarify our understanding of life in unfamiliar environments. This material will be the subject of another paper to be presented by me at this summer's COSPAR symposium.

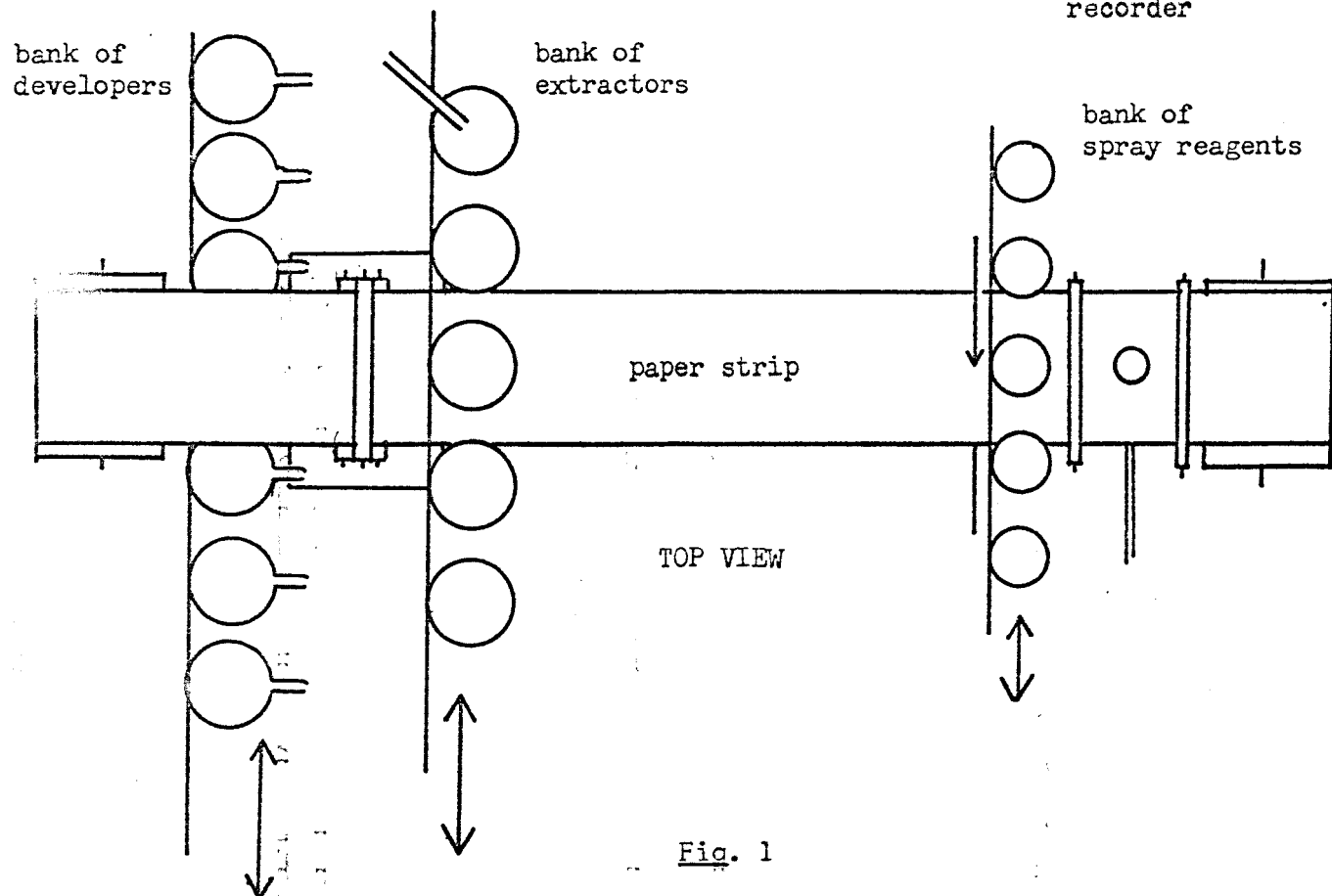
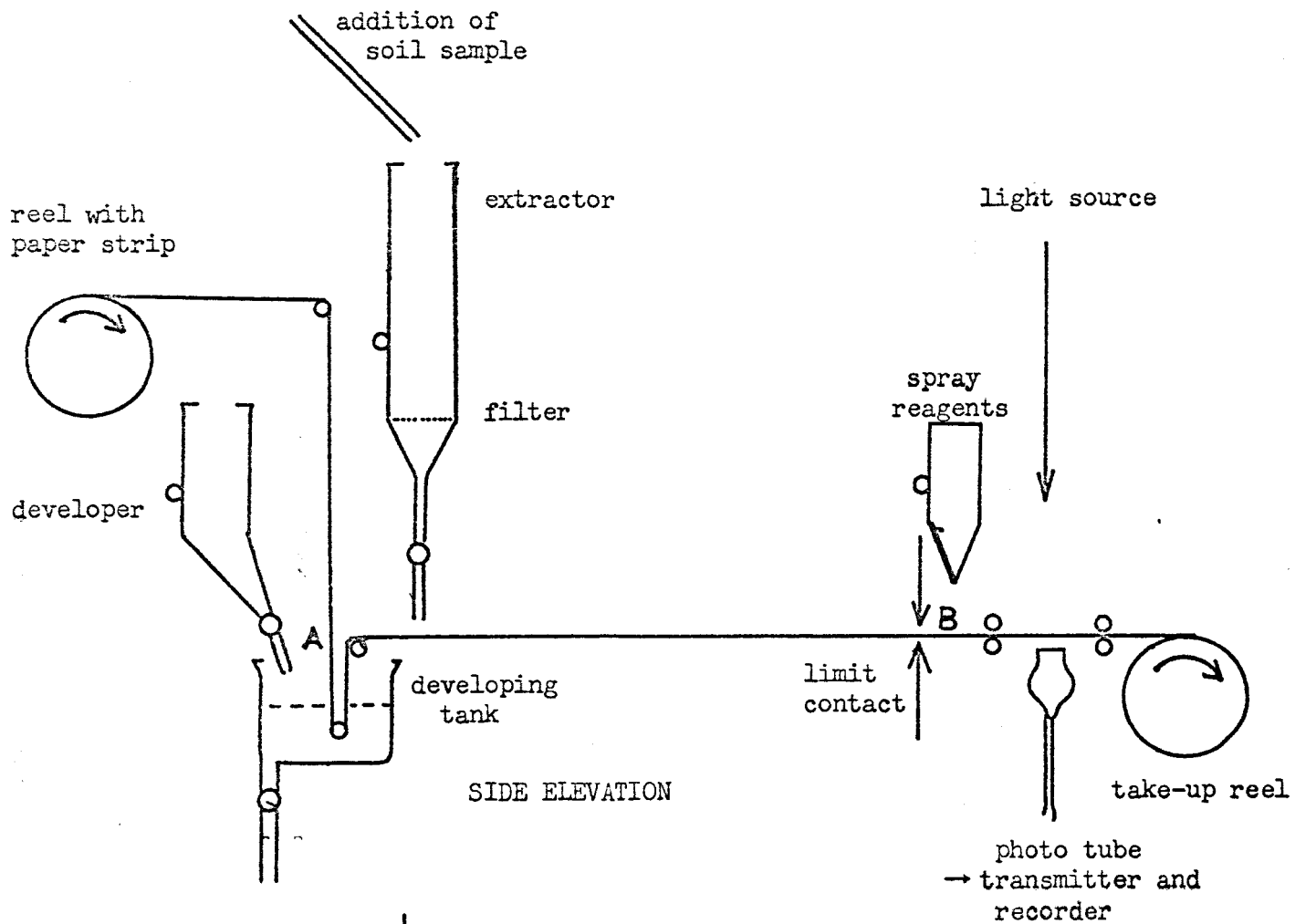
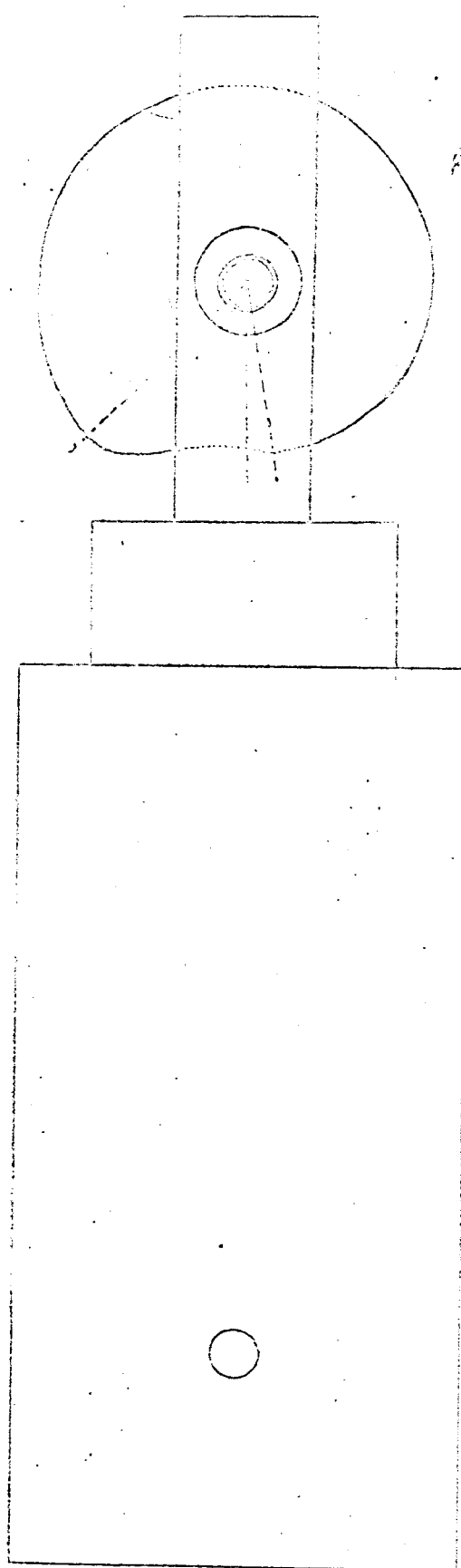
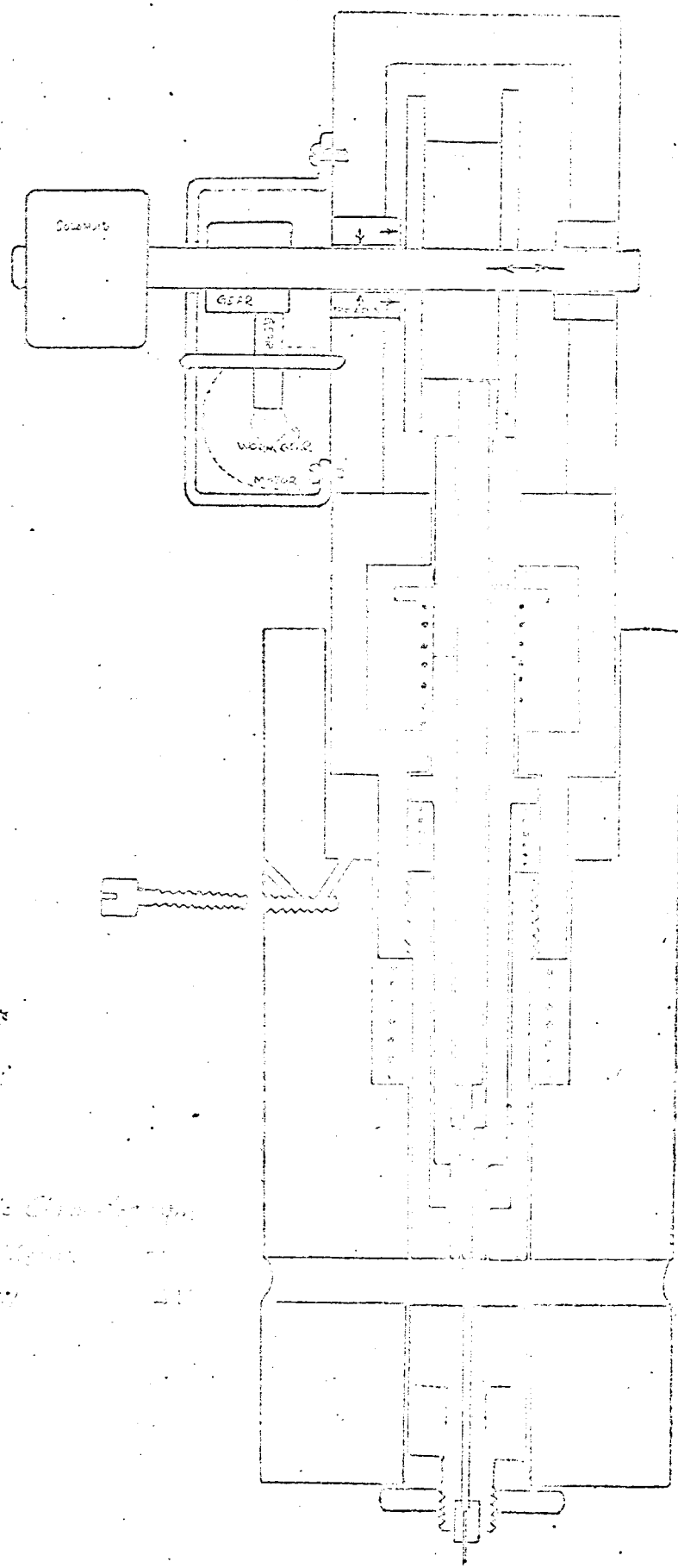


Fig. 1



Automatic Control System
 Control System
 15 17